as Mr. Stevens, on whose authority Stuart Baker apparently includes it, now doubts whether it occurs there, it is still however to be found in Native Sikkim, Icame across it there during a trip last June. According to a distribution map of this bird as collected or observed by Major Bailey, C.I.E., made while I was on a visit to him, it appears to be found slightly further East in Bhutan than given in Beebe's map and probably extends right across that country. He has lately got specimens alive from Ha in Bhutan.

The first intimation I got as to the further Eastern extension of this species was in a letter from Mr. Cooper, dated Sadiya, 7th February 1923, in which he wrote:—"However, I send herewith a photo of a Monal pheasant which I believe to be *impejanus* and not *sclateri*. (The photo is not good and is therefore not reproduced but the spatulate feathers could just be seen on the top of the head.) In Baker's book he puts the east limit of this pheasant at Bhutan. If this is *impejanus* he certainly goes east of Mishmi Hills. This pheasant was brought as a present to the A. P. O. here from the Delei Valley or east of it."

I showed this letter and photograph to Mons. Delacour when he was here and at first he thought it might possibly be *l'huysii*, but on examining it carefully through a lens the spatulate feathers of the crest were quite plain. About the end of last year, through the courtesy of the Political and Assistant Political Officers at Sadiya, I was able to get positive proof of this. Four skins of Impeyan pheasants. were kindly sent to me, three of which were *sclateri* and one a cock *impejanus*. I wrote enquiring as to the locality in which they were found and received the following reply from Mr. Godfrey, Asstt. Political Officer, dated Sadiya 28th January 1924 : "The monals, the skins of which we sent you were found near the snow line (8,000′) on either side of the Delei valley. Mishmis state that they are also found as far east as the hills of the Dou Valley. I had an ordinary monal cock brought in last year (evidently the one whose photograph Cooper sent me. C. M. I.) but it died as soon as the weather became hot and unfortunately I was unable to save the skin. . . . . The Mishmis have only one name *Pia-Padai* for the Monals and make no effort at distinguishing the various kinds."

As no skins have been forthcoming from the Dou Valley, we cannot say whether both species or only *sclateri* occurs there but that both are found in the Delei Valley is now proved. There still remains a big gap between Bhutan and this valley from which no specimens have been obtained but it seems improbable that *impejanus* should occur in an isolated tract far from its ordinary habitat and I think we may correctly presume that it is found, in suitable country, right across from the S. E. of Kabul to the Delei Valley in the Mishmi Hills on the North-East Frontier of Assam.

DARJEELING,
28*th July* 1924.

C. M. INGLIS,
F.Z.S., F.E.S., M.B.O.U.

No. XVI—THE MECHANICS OF THE SOARING BIRD.

May I invite the aid of the members of your Society to solve the problem of what may be called the "Mechanics" of the *soaring* bird. The information I seek is not contained in any text book in English or French on soaring flight.

(1) *Efficiency.*—We measure the efficiency of an aeroplane by the angle of its glide. The steepness or "flatness" of the gliding slope is entirely governed by the resistance ("drift" or "drag") of the aeroplane. In a typical modern aeroplane we find it hard to better a slope of 1 in 8. What is the gliding angle of typical soaring birds—say of the common vulture (*Pseudogyps bengalensis*)

and the cheel or common kite (*Milvus govinda*) ? The difficulty in measuring this angle is that any air movement whether horizontal or vertical will falsify the results. The most hopeful line of attack is to disturb soaring birds on stil days after sun down when " soaring " has ceased. Some success has been achieved on these lines, but many more observations are required.

(2) *Wing characteristics.*—Assuming that the gliding angle of a soaring bird is very fine we must attribute much of the efficiency to the wing section employed. The smoothness of the body, absence of struts, etc., will only partially account for the good gliding angle (in an aeroplane these resistances are only about 30 per cent. of the whole) since the greatest single resistance is almost certainly the horizontal component of the air pressure on the wings.

Now a wing may be defined by its dimensions, *i.e.*,length and breadth or as we say span and chord, by its chamber or the curvature of the wing with regard to the cord, and by its angle of incidence with which the chord meets the air. The first characteristic is easily obtained and data are in existence, the last is a matter of averaging many estimates under different conditions,*i.e.*, ful spread climbing (this is usually " circling ") or half furled gliding just horizontally. The camber is difficult to get. A fresh killed bird may be taken, turned upside down and the wings extended to any one typical soaring attitude. The camber now seen is a false one since in flight the wings must be supporting the weight of the body. We must therefore load the single wing with sand to represent half the weight of the body and this sand loading should be graduated from root to tip and front to rear : the greater load being nearest the root and nearest the front edge respectively. It is difficult to distribute this load scientifically, but as a rough guide the inner half of the wing should sustain $\frac{2}{3}$rds of the wing load, and the forward $\frac{1}{2}$ of the wing should sustain $\frac{2}{3}$rds of the load appropriate to any given " segment". For example if the single wing loading of a large vulture were 99 ozs., 66 ozs.,would be sustained by the inner half the wing and 33 ozs. by the outer—(these loads would be graduated within their respective halves so that a given square inch nearer the root would be heavier loaded than any square inch further in a line along the span towards the tip). Now of the 66 ozs. on the inner half 44 ozs. would be borne by the *front* half of the $\frac{1}{2}$ wing and only 22 ozs. by the rear. By a rough and ready loading in this manner followed by a fixing of the wing and the removal of the loading material we shall get some small idea of the camber employed. This will vary all along the wing, and I should like a drawing of say 5 typical sections along the half span for wings both full spread and half furled.

(3) *Tail functions.*—I should be glad of observations on the functions of the tail.

In an aeroplane if we raise the rear edge of the tail the wind pressure on the raised edge depresses the whole after portion of the machine and the result is a climb : in a bird the result appears to be precisely the opposite, the tail being jerked up to *descend.*

In an aeroplane the vertical rudder is turned towards the side to which it is desired to turn : a cheel is constantly revolving its tail without apparent influence on its direction. And when a movement of the tail accompanies a turn sometimes this tail movement appears to be in the " correct " sense judged by aeroplane practice, and just as often incorrect. In other words a marked depression of the starboard end of the tail may accompany a turn to starboard *or to port.*

There is little doubt that a bird steers with its wing tips, but what then is the function of the tail ? Its movements are apparently small in vultures, but it is never still in the case of the cheel. Dissection may show that the root of the tail is the seat of a great number of sensory nerves from which we might infer that the tail is largely a wind vane to feel the currents, or some other explanation may be put forward. The matter is of considerable interest.

There are other points still obscure, but this letter is already long enough. A reprint of a lecture on "gliding" which will appear in the April journal of the United Service Institution of India will give any of your members who are interested food for more thought.

Any observations sent by your member to me at Headquarters, Royal Air Force, India, will be gratefully received.

R. A. F. HEADQUARTERS,
DELHI, 12*th January* 1924.

J. A. CHAMIER, C.M.G., D.S.O., O.B.E.,
Group Captain,
Royal Air Force.

With reference to Capt. Chamier's enquiry on the above subject I hope our members in general, and Capt. Chamier in particular, will not consider this effort of mine, a case of fools stepping in where angels fear to tread! As one keenly interested in the flight of the larger birds the subject is full of interest to me, but whether the observations of a layman can be of the least use in shedding light on Capt. Chamier's difficulties is quite another matter.

However, on the assumption that even negative information might lead to something and give rise to comments by some who have already studied the subject, and induce others to watch for, and work out, the points raised by Capt. Chamier, I take the liberty of starting the ball rolling.

(1) *Efficiency.*—I have tried to observe the angle of slope of a soaring bird on several occasions, but am afraid I have not met with much success. Capt. Chamier says that any air current will falsify the result, and how is one to know whether there is any air current just where the birds happen to be soaring?

I have selected a period of the day when, so far as I could judge, it was dead still. Not a leaf stirred and even the sand one threw up fell only just off the vertical.

A number of vultures rose from the ground and began to soar.

A great deal of flapping of wings was necessary until they rose about 100 or 150 feet from the earth but, thereafter, they were able to circle on steady pinions, their wings being at full stretch.

Elevation was not gained by these birds gradually throughout the spiral but, seemingly, at only one point in the circle. They flew round clock-wise, and I noticed that they rose visibly when furthest from me and facing north and then, as they turned, they seemed to lose elevation. After a little time some of them changed direction and circled in the opposite direction, *i.e.*, anti-clock-wise. This change, however, did not effect them in so far as they too gained elevation when facing north and lost it when they turned.

I concluded that they gained when they breasted an air current and lost it when they turned and flew down wind and therefore the wind must be blowing from north to south. I again tried throwing up a little fine dust and noticed that a little of it was blown off the vertical to the west, *i.e.*, what breeze there was must have been from east to west.

There was no appreciable difference in speed at any point of the circle and the birds flew at about the same pace whether breasting the current or flying with it.

Occasionally an individual could be seen with an appreciable slope from head to tail but this was the exception and, for the most part the birds remained on an even keel, so far as one could see, and yet they gained elevation all the time. In under ten minutes they were mere specks.

There was a certain amount of "banking" when they turned from the point at which they gained elevation and the wing on the inner side of the circle was distinctly lower than the other.

On another occasion I watched a number of vultures leave the trees on a canal bank, quite near me. There was an appreciable wind blowing and the birds went straight up against it and began circling almost at once on outstretched